Tank Geometry and Volume Propellant Requirements
January 1997

Table 1
Tank Volume Requirements

Requirement	RP-1 Tank	Combined LOX Tanks
Usable Mass	8647 lbm	18852
Loaded Mass	8939 lbm	21015 lbm
Density (on ground)	50.5 lbs/ft^3	71.25 lbs/ft^3
Residual Propellant	292 lbm	266 lbm
Ullage (on ground)	2 Percent of Total Volume	2 Percent of Total Volume
Loss of Volume Due to Internal Hardware	0.3 Percent of Total Volume	0.3 Percent of Total Volume
Boil-Off	Not Applicable	1285 lbm
Chill Down	Not Applicable	612 lbm
Loss of Volume Due to Contraction	Not Applicable	1.2 Percent of Total Volume
Tank O.D	62.00 Inches	54.00 Inches
Wall Thickness	0.10 Inches	0.125 Inches
Dome Height	0.707R	0.707R
Access Door Radius	10.00 Inches	10.00 Inches
Total Required Volume	**181.18 ft ^3**	**305.64 ft^3**

Table 2
LOX Tank as Designed Volumes

Item	Spread Sheet	IDEAS Model
Forward Tank, Forward Compartment	39.20	39.10
Forward Tank, Middle Compartment	39.20	39.10
Forward Tank, Aft Compartment	45.29	46.00
Forward Tank Total	**123.69**	**124.20**
Aft Tank, Forward Compartment	44.68	44.57
Aft Tank, Second to Forward Compartment	44.68	44.57
Aft Tank, Second to Aft Compartment	44.68	44.57
Aft Tank, Aft Compartment	47.01	47.71
Aft Tank Total	**181.05**	**181.44**
Combined LOX Tanks	**304.74**	**305.64**

Table 2 lists the calculated volumes for the LOX design in Figure 2 and 3. Two methods, a spread sheet and an IDEAS 3-D model were used to calculate the volumes. As listed in Table 2, the two methods are within 0.4 percent of each other.

Table 3
RP-1 Tank as Designed Volumes

Item	Spread Sheet	IDEAS Model
RP-1 Tank, Forward Compartment	61.95	61.86
RP-1 Tank, Middle Compartment	61.95	61.86
RP-1 Tank, Aft Compartment	65.01	65.17
RP-1 Tank Total	**188.91**	**188.90**

Table 3 lists the calculated volumes for the RP-1 design in Figure 4. Two methods, a spread sheet and an IDEAS 3-D model were used to calculate the volumes. The two methods provide nearly identical results, however, the design is 4.3 percent larger than the requirement. Due to the uncertainties with the LOX loading, the RP-1 tank structure will not be modified at this time.

Table 4
Mass Properties for the LOX and RP Tanks

Item	RP-1 Tank	Forward LOX Tank	Aft LOX Tank
Total Load Propellant	8939 lbs	8540 lbs	12475 lbs
(Total Usable Propellant)	8647 lbs	7661 lbs	11191 lbs
Tank Structure	204.7 lbs	419.9 lbs	564.5 lbs
Total	**9179.7 lbs**	**8959.9 lbs**	**13039.5 lbs**
Predicted c.g. (Vehicle Station Location)	325.8	461.4	608.2

The current mass properties of the tanks are defined in Table 4 for each of the tanks. The mass properties are for the fully loaded, on the ground condition. The c.g. is assumed to be half way between the attachment bulkheads. Note, the mass of the structure does not include any components attached to the tank, the close-out doors, or the attachment of the tank to the bulkhead.